

Identity and identification of *Trogulus banaticus* (Opiliones: Trogulidae) – a neglected species in the Northern Balkans

Axel L. Schönhofer & Tone Novak

doi: 10.5431/aramit4202

Abstract: *Trogulus banaticus* Avram, 1971 is characterised and recorded as new for Slovenia. This species was previously mistaken for *T. coriziformis* C. L. Koch, 1839 and *T. graecus* Dahl, 1903 which were later rejected from the Slovenian fauna. *T. banaticus* is compared with the similar, and partly sympatric, *T. tingiformis* C. L. Koch, 1847 with which it has often been confused. A table of distinguishing characters for both species is provided, and the ecology of *T. banaticus* and its general distribution are discussed.

Key words: Bosnia and Herzegovina, ecology, Macedonia, Montenegro, Romania, Serbia, Slovenia, taxonomy, *Trogulus tingiformis*

The genus *Trogulus* Latreille, 1802 has long been known to be a problematic group in terms of taxonomy and species delineation (MARTENS 1988). Recent integrative studies incorporating molecular, morphological and biogeographical data (SCHÖNHOFER & MARTENS 2008, 2009, 2010) revealed a large number of cryptic species necessitating clear definitions of already described species. Yet many descriptions were insufficient causing species to be neglected in research on Opiliones in Central Europe. This was the case of *Trogulus* species described by AVRAM (1971), several of which were based upon one or only a few specimens and accompanied by hard/difficult to understand taxonomic drawings. Of Avram's six new species, three were assumed to be based on defective specimens with a broken glans stylus. MARTENS (1978) therefore synonymised *T. gruberi* Avram, 1971 with *T. tingiformis* C. L. Koch, 1847 and WEISS (1978) supposed the same defect for *T. galasensis* Avram, 1971 and *T. roeweri* Avram, 1971 which he referred to *T. nepaeformis* (Scopoli, 1763). Apart from this substantial criticism, the remainder of Avram's species were treated slightly more positively. Because of the poor drawings and the assumed high variability in *Trogulus* species, MARTENS (1978) synonymised *Trogulus closanicus* Avram, 1971 with *T. nepaeformis*, and *T. oltenicus* Avram, 1971 with *T.*

tricarinatus (Linnaeus, 1767). It was WEISS (1978), in possession of a rich material from Podu Olt in Romania, who confirmed the validity of both Avram species based on a morphometric analysis. Later on, CHEMINI (1984) re-described *T. closanicus*, which is the only one of Avram's species that became widely accepted and cited in literature, while *T. oltenicus* still suffers from having little attention due to the lack of a sound re-description and its unknown geographic distribution in southern Romania.

Yet, there is another of Avram's species, *Trogulus banaticus* Avram, 1971 that still lacks a clear statement concerning its validity. WEISS (1978) questioned the description as based on only a single male. WEISS (1996) mentioned *T. banaticus* from North-eastern Romania but commented on this record being located far from the type locality and the general need for *Trogulus* revisions. Recently, it was listed by BABALEAN (2004, 2005) in checklists of the Romanian fauna, without further comment. Although the Avram types were not available from the Bucharest Museum, investigation of a comprehensive collection of *Trogulus* material from Europe yielded an understanding what Avram actually perceived as *T. banaticus*. We therefore were able to use the name in previous contributions, prior to a re-description (SCHÖNHOFER & MARTENS 2008, 2009, 2010).

Here, we aim to outline the important characteristics to identify the species and to delineate it from the sympatric *T. tingiformis* which is of comparable body size and similar morphological key characters. Reasons why *T. banaticus* was neglected for so long are discussed, and a brief overview of its distribution and ecology is given. Detailed data are provided for Slovenia and an outline of the assumed distribution

Axel L. SCHÖNHOFER, Department of Biology, Life Sciences North, San Diego State University, San Diego, CA 92182-4614, USA, E-Mail: Axel.Schoenhofer@uni-mainz.de

Tone NOVAK, Department of Biology, Faculty of Natural Sciences and Mathematics, University of Maribor, Koroška cesta 160, SL-2000 Maribor, Slovenia, E-Mail: Tone.Novak@uni-mb.si

eingereicht: 26.3.2011, akzeptiert: 30.7.2011; online verfügbar: 15.12.2011

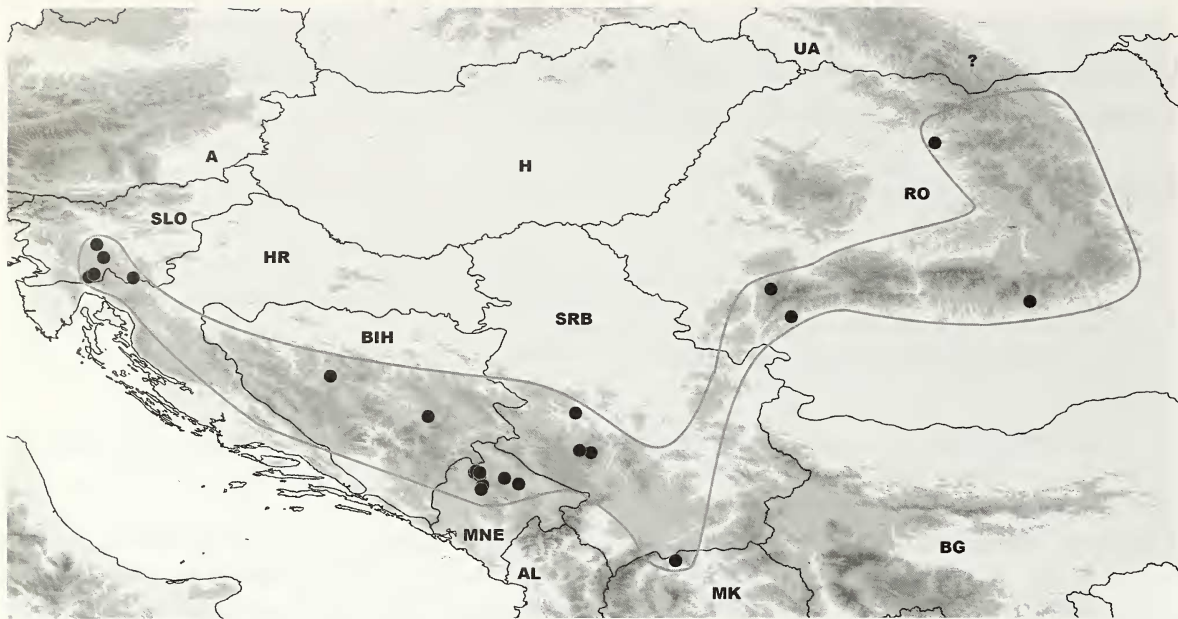


Fig. 1: Generalized possible distribution of *Trogulus banaticus* based on present records (black dots). Albania (AL), Austria (A), Bosnia and Herzegovina (BIH), Bulgaria (BG), Croatia (HR), Hungary (H), Macedonia (MK), Montenegro (MNE), (Romania (RO), Serbia (SRB), Slovenia (SLO), Ukraine (UA).

based on already confirmed records is shown (Fig. 1). A full description for *T. banaticus* listing all records is intended within a revision of the *Trogulus torosus* species group, for which the investigation of material is still in progress.

Material and methods

Material discussed is deposited in the working collections of Jochen Martens in the Institute of Zoology, Mainz University, Germany (Collection J. Martens: CJM) and Tone Novak and Ljuba Slana Novak, Slovenj Gradec, Slovenia (Collection Novak and Slana: CNS) and the Naturkunde Museum Berlin (ZMB, Jason Dunlop). The geodetic reference date used was WSG84.

Comparative material of *Trogulus banaticus*:

Slovenia: Travni Dolci, Mt. Snežnik, 1350 m, beech forest edge, sieving, VL54, N: 45.574°, E: 14.436°, 2 subad., 1 juv., L. Slana Novak, T. Novak leg. 12.08.2001 (CNS 197/2001); – Runarsko, 768 m, VL66, N: 45.771°, E: 14.547°, 1♂, I. Sivec leg. 16.02.1989 (CNS 1051/1997); – Krim, 950 m, VL68, N: 45.927°, E: 14.470°, 1♂, I. Furlan leg. no date (CNS 91/1995); – Albeljska jama cave, 525 m, Cad. No. 3852, Suhor, VL94, N: 45.537°, E: 14.373°, 1 juv., L. Slana Novak, T. Novak leg. 23.07.1999 (CNS 95/1999); – Ograja near Zdihovo, 520 m, shrubs, sieving, N: 45.528°, E: 14.906°, 1♀, L. Slana Novak, T. Novak leg. 26.06.1999 (CNS 77a/1999); – **Bosnia and Herzegovina:** Sarajevo, BP93, 1♂, no further data (CNS 40/1985); – Jajce, 450 m,

N: 44.34° E: 17.26°, 1♂, Verhoeff leg. Sept. (ZMB 12083; sub *T. rostratus*); – **Macedonia:** Skopje; Mt. Skopska Crna Gora, Banjane, monastery Sveti Ilija, 618 m, stream valley, deciduous forest, in deep stony gravel and from sieving close to river, N: 42.083°, E: 21.383°, 4♂, 1♀, 3 juv., A. Schönhofner, I. Karaman, M. Komnenov leg. 16.04.2006 (CJM 4936); – **Romania:** Gorj, Lupsa Valley near Closani, 407 m, beech forest, under stones, N: 45.050° E: 22.767°, 1♂, 2♀, A. Schönhofner, R. Plăiașu leg. 03.05.2006 (CJM 4927); – Prahova, Comarnic, 600 m, N: 45.23° E: 25.63°, 1♂, 1♀, C. Tencușe leg. 14.06.2003 (CJM 4317); – Bistrița-Nasaud, Pădurea Codrișor, Bistrița, N: 47.13° E: 24.50°, 4♂, 2♀, A. Hodoroga leg. 1988, I. Weiss det. (CJM 2895, WEISS 1996); – **Serbia:** Ovčar Banija, monastery Preobraženje, 322 m, beech forest with *Allium ursinum*, under stones, N: 43.900° E: 20.184°, 1♂, 1 juv., A. Schönhofner leg. 07.05.2006 (CJM 4840).

Further records shown in Fig. 1 refer to the type locality in Romania (AVRAM 1971) and records listed as *T. tingiformis* in ČURČIĆ (1990) in Southern Serbia and KARAMAN (1995) from the Durmitor area in Montenegro, we in most cases could determine as *T. banaticus*.

Comparative material of *Trogulus tingiformis*:

Romania: Bistrița-Nasaud, Pădurea Codrișor, Bistrița, N: 47.13° E: 24.50°, 15♂, 10♀, 2 juv., A. Hodoroga leg. 1988, I. Weiss det. (CJM 2902-2903; WEISS 1996); – **Slovenia:** Runarsko, 768 m, N: 45.771°, E: 14.547°, 4♂, 5♀, I. Sivec leg. 16.02.1989 (CNS 1051/1997).



Figs. 2-7: Hood and prosoma (upper row), body (lower row) of *Trogulus tingiformis*, 2-3: Romania, Bistrița, CJM 2903; *T. banaticus*; 4-5: Romania, Closani, CJM 4927; 6-7: Slovenia, Runarsko, TN 1051/1997; scale bars 1.0 mm.

Original line drawings were produced using a camera lucida attached to a Wild Heerbrugg M5A Dissecting Microscope and a Leitz Laborlux Microscope. Resulting drawings were vectorised using a Wacom Bamboo tablet CTH-460 and Inkscape 0.48. Photographs of specimens were taken with a Nikon D80 attached to the M5A, and refined with CombineZP and Photoshop CS4.

Results

The identification of *Trogulus banaticus* was based on material collected close to the type locality in Romania

(CJM 4927) and re-evaluation of the original description by AVRAM (1971). The main differences between *Trogulus banaticus* and *T. tingiformis* which enable easier identification of these partly sympatric – and frequently confused – species are listed in Table 1.

Genetic divergence estimated from direct comparison of 552 bp cytochrome b sequences of the series CJM 4317, 4840 and 4927 show a divergence of ~1 % between the sequences of these individuals, pointing to low intraspecific and geographic variation between *T. banaticus* from Romania, Serbia and Macedonia (SCHÖNHOFER & MARTENS 2010).

Diagnosis of *Trogulus banaticus* Avram, 1971

Figs. 4–7, 12–17, 19–20, 22

Medium-sized to large *Trogulus* (body size ♂ (n=36): 7.65–9.55, ♀ (n=30): 9.55–11.64; Figs 5, 7) with broad and compact body of a brown to dark brown coloration with blackish tinge (specimen shown are bleached in alcohol); legs short, stout, segments of tarsus II equal in length (Figs 19–20, 22); conspicuous dorsal papillation pattern (clearly seen in Fig. 4), ridges, especially the median one, elevated or even strongly elevated; hood large with respect to body length (male body length/length of hood = ~6.5; Figs 4–7), rhombic to rounded, with branches continuous narrowing distad, shaping area of inner papillation roughly triangular to round triangular; eyes and eye mound large and elevated; eyes large, with wide black surrounding field; suture between pro- and opisthosoma bent in a wide curve to opisthosoma; hind end of opisthosomal plate strongly bent dorsad.

Base of penis (Figs 12–15) drawn out in two root-like structures, truncus constricted above the base, then gradually widening towards the middle and then tapering without remarkable intersection or

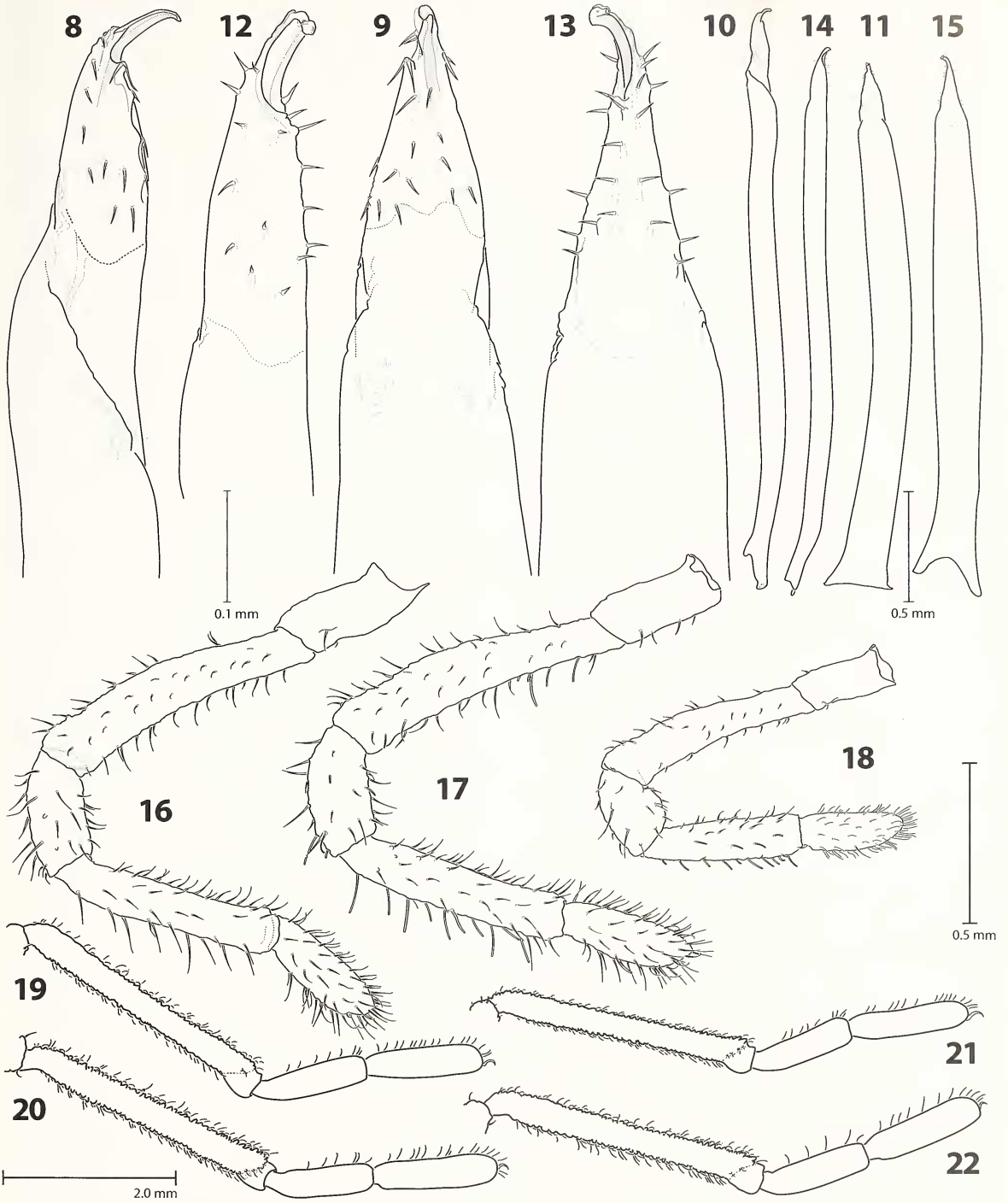
bump into the glans; glans very slender and elongated, tapering into the narrow stylus. Stylus in straight elongation with the truncus, blunt, with shallow dorsal groove tapering proximad, bent laterad in distal part and ending as a small rectangular tip.

Discrimination from *Trogulus tingiformis*

Trogulus tingiformis and *T. banaticus* distributional areas broadly overlap in Romania, where they are partly syntopic (Bistrița, WEISS 1996). In Slovenia they appear to be sympatric and often syntopic (Runarsko) in its limited southern part – the north-easternmost area of *T. banaticus*. Other records of *T. tingiformis* overlapping the area we presume here for *T. banaticus* have been published by AVRAM (1971, sub *gruberi*; MARTENS 1978), yet many of the authors did not discriminate between the two species or ignored *T. banaticus* altogether. The identification of *Trogulus* species has often been reduced to investigations of body size and the relative lengths of the articles of tarsus II. As these characters are very similar in *T. tingiformis* and *T. banaticus*, the two species may thus be easily confused. We therefore provide a number of

Tab. 1: Diagnostic differences between *Trogulus banaticus* and *T. tingiformis*. Receptaculi seminis are very similar in both species and these differences are therefore not elucidated here.

<i>Trogulus banaticus</i>	<i>Trogulus tingiformis</i>
proportion of head cap to body small, i.e. relatively large head (Figs 5, 7)	proportion of head cap to body large, i.e. relatively small head (Fig. 3)
lateral borders of prosoma clearly concave (Figs 4, 6)	lateral borders of prosoma straight (Fig. 2) or scarcely concave
area of median papillae of hood roughly triangular to rounded triangular (Fig. 4, 6)	area of median papillae of hood elongated elliptic or rhomboid (Fig. 2)
abrupt change of papillation density from central median ridge to surrounding area (clearly seen in Fig. 5)	gradual to no change of papillation density from central median ridge to surrounding area (Fig. 3)
body colour dark brown with blackish tinge (specimen shown bleached)	body colour brown with reddish tinge (Fig. 3)
body and legs broad (Figs 5, 7)	body and legs more slender (Fig. 3)
suture between pro- and opisthosoma in midsection strongly bent to opisthosoma (Fig. 4)	suture between pro- and opisthosoma nearly straight, only slightly bent (Fig. 2)
hairs on legs straight, pointing more dorsad than distad, longer (Figs 19–20, 22)	hairs on legs bent at a low angle to distad, often blunt and inconspicuous, shorter (Fig. 21)
distinct y-shaped ridges on prosoma (Fig. 4)	prosoma without a distinct papillation pattern (Fig. 2)
stylus of penis slightly bent dorso-laterad (Fig. 12–13)	stylus of penis bent dorsad in total length (Fig. 8–9)
truncus of penis constricted above base and widened in midsection (Fig. 15)	truncus of penis more or less parallel sided (Fig. 11)
palpus very large and elongated (Figs 16–17)	palpus small, segments stout (Fig. 18)



Figs. 8-22: 8-11, 18, 21: *Trogulus tingiformis*, Romania, Bistrița (CJM 2903); 12-17, 19-20, 22: *T. banaticus*; 12-16, 19: Slovenia, Runarsko (TN 1051); 17, 20: Romania, Clossani (CJM 4927); 22: Macedonia, Skopje (CJM 4936); 8-9, 12-13: Glans of penis; 10-11, 14-15: Total penis; 16-18: right palpus, medial view; 19-22: right tarsus, lateral view; 9, 10, 12, 14: lateral view; 9, 11, 13, 15: dorsal view.

differential characters (Table 1) to enable discrimination.

Ecological and biogeographical remarks on *T. banaticus*

The few detailed records, mainly from our own collections, show *Trogulus banaticus* inhabiting deciduous forests over calcareous bedrock. While this is an environment favoured by many *Trogulus* species, *T. banaticus* seems to require special microhabitats. So far, most described habitats feature a rocky surface layer, often composed of multiple layers of stones, allowing transit through their interstitial system. Here *T. banaticus* is found in the humidity-saturated loamy parts. In view of other members of the *Trogulus torosus* species-group, a preference for cool microhabitats seems to be a common requirement. In Slovenia, a record from a cave wall (Albeljska jama) a few meters below the surface during the hot summer days is highly consistent with these findings, while deep beech litter localities (Travni Dolci, Ograja) indicate that bare, loamy substrates might be preferable only in places where other cold and wet habitats are missing or, on the other hand, these are just places where species of the genus *Trogulus* can more easily be noticed. In any case, in the north-westernmost part of the area in Slovenia, the occurrence in deep litter might be a false experience for the sparse number of investigated localities.

Aside from *T. tingiformis*, *T. banaticus* co-occurs with a number of other species, such as *T. closanicus* and *T. oltenicus* in the western Carpathians, *T. nepaeformis* species aggregate (agg.) from Montenegro to Slovenia and the *T. tricarinatus* agg. across all of its range. *T. banaticus* seems not to enter the endemism-rich zone of the Southern Dalmatian Coast, outlined by *T. torosus* Simon, 1885, *T. squamatus* C. L. Koch, 1839 and *T. hirtus* Dahl, 1903; they are all roughly distributed from Montenegro to Split in Croatia. It is interesting that the distribution of *T. banaticus* hereby matches that of other Carpathian-Central Dinaric faunal elements, such as *Holoscotolemon jaqueti* (Corti, 1905) and *Carinostoma elegans* (Sørensen, 1894); both are not present in the endemism zone either. Yet in addition, *T. banaticus* overlaps the Dinaric area part of the *T. falcipenis* clade (SCHÖNHOFER & MARTENS 2008), always following the main mountain chains which provide the necessary lithoclastic habitats.

Discussion

Comparing the original description (AVRAM 1971) with this new material, *T. banaticus* appears to be easily recognisable within the European set of *Trogulus* species. In spite of its large distribution area (Fig. 1) it remained un-entangled for such a long time for reasons explained in the introduction, and because of the complex faunal setting along the Balkans, accompanied by misidentification of other similar *Trogulus* species. For example *T. banaticus* material from Bosnia and Herzegovina, Serbia, Macedonia and Montenegro was misidentified as *T. tingiformis* (KARAMAN 1995, ČURČIĆ et al. 1999) and later, when this mistake became apparent, they were formally referred to *T. graecus* Dahl, 1903, due to general similarities with this species. In Slovenia – which displays a transition zone between Mediterranean, Alpine and Dinaric faunas – even more possibilities to misidentify *T. banaticus* arose. According to the first mapping, *T. coriziformis* C. L. Koch, 1839 was also alleged for Croatia (MARTENS 1978, NOVAK 2004) and, based upon a juvenile specimen (CJM 1617), NOVAK et al. (1995) and NOVAK & GRUBER (2000, sub *T. cf. coriziformis*) erroneously listed the species for Slovenia. Therefore the first record of *T. banaticus* from Slovenia (Runarsko) was informally given as belonging to *T. coriziformis*; a species now excluded from the Slovenian (NOVAK 2005b) and Croatian fauna, supported by the revision of the associated species group (SCHÖNHOFER & MARTENS 2008). Afterwards the Slovenian records were affiliated with the *T. graecus* species group (NOVAK et al. 2006). Yet, the records associated with *T. graecus* remained questionable, as the habitat and distribution seemed an inappropriate match for this xerothermic species with a far more southern Balkan distribution. NOVAK (2005a) refuted the presence of *T. graecus* in Bosnia. Finally, newly collected material of *Trogulus banaticus* (CJM 4927) from the terra typica in Romania has enabled a reinterpretation of Avram's species. Molecular investigation confirmed this series to be conspecific with other specimens from Romania (CJM 4317) and Southern Serbia (CJM 4840; cf. SCHÖNHOFER & MARTENS 2010). This enabled us to revise the records of *T. graecus* in the Central and Northern Balkans, including Slovenia, and to assign most of them to *T. banaticus*. At this point Ingmar Weiss has to be credited, because he, in 1996, already recognised differences between syntopic *T. tingiformis* and *T. banaticus* in Romania.

Acknowledgements

We thank Ingmar Weiss (Grafenau, Germany) and Anda Babalean (Craiova, Romania) for their generous donation of material to J. Martens, who in turn provided it for this study. Rodica Plăiașu (Bucharest, Romania) accompanied A. S. during a collection trip to Closani in the Western Carpathians and sent further material from this area. Ivo Karaman (Novi Sad, Serbia), Marjan Komnenov and Slavko Hristovski (both Skopje, Macedonia) helped and supported A. S. collecting in Macedonia, and Ljuba Slana Novak helped with collecting in Slovenia. Ivo Karaman made material of published records from Serbia and Montenegro available. We are indebted to Jochen Martens and Christian Komposch for insightful comments on the manuscript, and to Jason Dunlop for linguistic improvements. A. S. was financially supported by a DAAD (Deutscher Akademischer Austauschdienst) travel grant to collect material for his doctoral thesis. T. N. was partly supported by the Slovene Ministry of High Education, Science and Technology within the Biodiversity research program (P1-0078). We heartily thank all friends, colleagues and institutions mentioned.

References

- AVRAM S. (1971): Quelques espèces nouvelles ou connues du genre *Trogulus* Latr. (Opiliones). – Travaux de l'Institut de Spéologie "Émile Racovitza" 10: 245-272
- BABALEAN A.F. (2004): On the opilionid fauna (Arachnida, Opiliones) from the SW part of Romania. – Acta Zoologica Universitatis Comenianae 46: 79-86
- BABALEAN A.F. (2005): General overview on the Opilionid fauna (Arachnida, Opiliones) in Romania. – Analele Științifice ale Universității „Al.I. Cuza” Iași, s. Biologie animală 51: 47-54
- CHEMINI C. (1984): Sulla presenza di *Trogulus closanicus* Avram in Austria, Baviera e Slovenia (Arachnida: Opiliones). – Berichte des Naturwissenschaftlich-Medizinischen Vereins in Innsbruck 71: 57-61
- ĆURČIĆ B.P.M., I.M. KARAMAN & V.T. TOMIĆ (1999): On some new and little-known epigeal harvestmen (Opiliones, Arachnida) from West Serbia, Yugoslavia. – Archives of Biological Science Belgrade 51 (4): 61-62
- KARAMAN I.M. (1995): Fauna opilionida (Arachnida, Opiliones) durmitorskog područja. Master thesis. Prirodno-matematički fakultet Univerzitet u Novom Sadu. 73 pp.
- MARTENS J. (1978): Spinnentiere, Arachnida – Weberknechte, Opiliones. – Die Tierwelt Deutschlands 64. G. Fischer, Jena. 464 pp.
- MARTENS J. (1988): Species boundary problems in Opiliones. – Newsletter of the British arachnological Society 52: 2-4
- NOVAK T., J. GRUBER & L. SLANA (1995): A contribution to the knowledge of the harvestmen (Opiliones) from the submediterranean region of Slovenia. – Annales, Series historia naturalis, Koper 7: 181-192
- NOVAK T. (2004): An overview of harvestmen (Arachnida: Opiliones) in Croatia. – Natura Croatica 13: 231-296
- NOVAK T. (2005a): An overview of harvestmen (Arachnida: Opiliones) in Bosnia and Herzegovina. – Natura Croatica 14: 301-350
- NOVAK T. (2005b): The harvestmen fauna (Arachnida: Opiliones) from the sub Mediterranean region of Slovenia – II. – Annales, Series historia naturalis, Koper 15: 103-114
- NOVAK T. & J. GRUBER (2000): Remarks on published data on harvestmen (Arachnida: Opiliones) from Slovenia. – Annales, Series historia naturalis, Koper 10: 281-308
- NOVAK T., S. LIPOVŠEK DELAKORDA & L. SLANA NOVAK (2006) A review of harvestmen (Arachnida: Opiliones) in Slovenia. – Zootaxa 1325: 267-276
- SCHÖNHOFER A.L. & J. MARTENS (2008): Revision of the genus *Trogulus* Latreille: the *Trogulus coriziformis* species-group in the Western Mediterranean (Opiliones: Trogulidae). – Invertebrate Systematics 22: 523-554 – doi: 10.1071/IS08013
- SCHÖNHOFER A.L. & J. MARTENS (2009): Revision of the genus *Trogulus* Latreille: the *Trogulus hirtus* species-group (Opiliones: Trogulidae). In KROPF C. & P. HORAK, (eds): Towards a natural history of arthropods and other organisms. In memoriam Konrad Thaler. – Contributions to Natural History 12: 1143-1187
- SCHÖNHOFER A.L. & J. MARTENS (2010): Hidden Mediterranean diversity: Assessing species taxa by molecular phylogeny within the opilionid family Trogulidae (Arachnida, Opiliones). – Molecular Phylogenetics and Evolution 54: 59-75 – doi: 10.1016/j.ympev.2009.10.013
- WEISS I. (1978): Biometrische und ökologische Untersuchung der Gattung *Trogulus* am Konglomerat von Podu Olt in Südsiebenbürgen (Arachnida, Opiliones). – Studii și Comunicări – Științe Naturale 22: 213-228
- WEISS I. (1996): Die Weberknechtfauna Siebenbürgens (Arachnida: Opiliones). – Stapfia 45: 259-280